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The vaccination characteristics and mortal causes analysis of COVID-19 deaths at a district level

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ABSTRACT

Aim: This study aims to analyze some demographic characteristics, vaccination status, and mortal causes of COVID-19 deaths retrospectively at a district level.

Material and Method: This cross-sectional study retrospectively analyzed 357 COVID -19 deaths between March 11, 2020, and April 30, 2022, in a large district of Istanbul with low socioeconomic status. Age, sex, marital status, date of death, causes of death, vaccination status and dates, and PCR test data (considered diagnostic data) were obtained from the District Health Directorate records.

Results: More than half of those who died were male (51.8%). The mean age was 71.1±13.3 years. As age increases, the death number also increases. 72.0% of all deaths were over 65 years old. The marital status of more than half of the deaths (54.8%) was married. 71.7% of all deaths were unvaccinated. Of those vaccinated among deaths, 85.4% received all vaccine doses with only inactivated virus vaccine. The mean time from diagnosis (PCR positive date) to death for COVID-19 deaths is 14.3±11.0 days. The mean time from the last vaccination date to death in the vaccinated group was 123.2±90.8 days. This period was statistically significantly different between those who received a single dose of vaccine and those who received two or more doses. Most COVID-19 deaths (67.5%) were caused by respiratory diseases. Among the causes of death coded with the ICD-10 diagnosis code in the death notification system, 53.8% of the deceased had a comorbid condition.

Conclusion: The most striking result of our investigations is that most COVID-19 deaths were unvaccinated or incompletely vaccinated. Those who were vaccinated were mostly immunized with inactivated vaccines. Based on the results, it can be concluded that vaccines effectively protect COVID-19 patients from death. However, the preventive effect of inactivated vaccines against death in COVID-19 is limited.

Keywords: COVID-19, death, vaccination status, mortal causes

INTRODUCTION

COVID-19 has spread worldwide, including Turkey, shortly after the first case was detected in Wuhan, Hubei Province, China, in December 2019 (1). The disease became the most important issue worldwide causing significant economic and social losses and numerous deaths. By February 17, 2023, COVID-19 has caused more than 750 million infections and nearly 7 million deaths worldwide (2).

Few studies in the literature retrospectively analyzed COVID-19 deaths (3–5). Also, no study examined COVID-19 deaths at the population level in Turkey. Understanding the underlying causes of death is important to reduce COVID-19 deaths.

The first COVID-19 case in Turkey was reported on March 11, 2020 (6); as of February 17, 2023, 17,004,677 confirmed cases have been reported with 101,419 deaths since the first case (7). Istanbul is the province where the first case occurred in Turkey and was the most affected during the pandemic. Sultanbeyli ranks 22nd among Istanbul's 39 districts in population size and has a low socioeconomic level due to immigration. In 2022, the district's population was 358,201; 51.2% were male (8).

The aim of this study was to retrospectively investigate COVID -19 deaths in an Istanbul neighborhood with a low socioeconomic level. In this context, our study aimed to answer the following questions,

1. What are the demographic characteristics of COVID-19 deaths?
2. What is the vaccination status of those who died from COVID-19?

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3. What are the mortal causes of COVID-19 deaths reported in the death notification system?
4. What is the mean time from diagnosis to death for COVID-19 deaths, and is there an association with vaccination status?

MATERIAL AND METHOD

The study was carried out with the permission of Istanbul Medipol University Non-Interventional Clinical Researches Ethics Committee (Date: 13.10.2022, Decision No: E-10840098- 772.02-6155). All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki.

Study Design, Population, and Data Sources

This cross-sectional study was conducted in Sultanbeyli, a low socioeconomic neighborhood of Istanbul. The research population consists of people who died of COVID-19 in this district. No random sampling was used in the study, but all COVID-19 deaths in the district between March 11, 2020, and April 30, 2022 were included.

Data Collection Method

Age, sex, marital status, date of death, and causes of death were taken from the death notification system. With the new death certificate introduced in Turkey in 2009, the causes of death were classified according to the International Classification of Diseases (ICD-10). In 2013, the document was transferred to digital media and renamed the Death Notification System. Physicians complete the death certificate for all deaths in all hospitals, health centers, family health centers, municipalities, forensic medical facilities, and other health care facilities. All completed death certificates are compiled in the provincial health directorates and forwarded to the relevant TurkStat regional directorates. The death certificate begins with Section A, which indicates the age, sex, marital status, and place of residence of the deceased. Section B contains the date and place of death. Section C divides the manner of death into natural and forensic, and communicable and non-communicable diseases. If the death was from an injury, there is a Section D that asks for the details of the injury. The document continues with sections E, which asks questions about autopsy if an autopsy was performed, F, which asks about infant mortality, and G, which addresses maternal death. Section H, which asks questions about cause of death, is divided into two subsections. The first part lists chronologically the diseases and conditions that lead directly to death. The second part lists other important situations that affect the realization of death but are not related to the disease that caused the death.

The vaccination status of the deceased individuals was obtained from the country's public health management system, where COVID-19 vaccinations were registered. In addition, the COVID-19 diagnosis dates of the people included in the study were obtained from the Statistics and Causal Analysis in Health application (SINA).

Definitions and Classification of Data

COVID-19 Death: All deaths between March 11, 2020, and April 30, 2022, for which one of the causes of death in the Death Notification System was defined as COVID-19, were considered COVID-19 deaths. The date on which the PCR test result was positive was accepted as the date of diagnosis.

Fully vaccinated: According to the CDC, individuals are considered "fully vaccinated" two weeks after receiving the second dose of a two-dose vaccine series COVID-19 (9).

Mortal causes: In the Death Notification System, diseases and conditions defined by ICD-10 codes were accepted as mortal causes.

Statistical Analysis

Continuous variables were expressed as mean±standard deviation and categorical variables as frequencies and percentages. The Shapiro-Wilk test was used to test whether a normal distribution was present. Continuous variables were compared using the Mann-Whitney U test, and categorical variables were compared using the chi-square test. All statistical analyses were performed with IBM SPSS Statistics for Windows version 25.0 (SPSS Inc., Chicago, IL, USA). Statistical significance was set at a p-value less than 0.05.

RESULTS

Between March 11, 2020, when the first case occurred in Turkey, and April 30, 2022, there were a total of 357 deaths associated with COVID -19 in the county. There were 169 deaths in 2020, 155 in 2021, and 33 in 2022. Two people died while infected with SARS-CoV-2 for the second time. The time between two positive findings was 14.5 months for one and 17.1 months for the other.

Data on age, sex, and marital status obtained from the death notification system are shown in **Table 1**. More than half of the deceased were male (51.8%). The mean age was 71.1±13.3 years. The mean age was similar in women and men (70.7 years in men, 71.5 years in women, $p > 0.005$). The lowest age was 29 years and the highest was 98 years. As age increases, so does the number of deaths, 72.0% of all deaths were over 65 years of age. The marital status of more than half of the deceased (54.8%) was married. It is noteworthy that 38.1% of them were widowed.

Table 1. Demographic characteristics of COVID-19 deaths

Characteristic	Number	%
Sex		
Male	185	51.8
Female	172	48.2
Age groups (years)		
40>	8	2,2
40-64	92	25,8
65 ≤	257	72,0
Marital status		
Married	199	55.7
Widow	136	38.1
Single	14	3.9
Divorced	8	2.2

According to **Figure 1**, which depicts the previous vaccination status of individuals included in the study, 71.7% of deaths due to COVID -19 were unvaccinated. Of the 82 fully vaccinated individuals, 85.4% received all doses of inactivated virus vaccine (CoronaVac). Of the others, 1.7% received all doses of mRNA vaccine (BioNTech), while 1.7% received mixed doses of inactivated and mRNA vaccine.

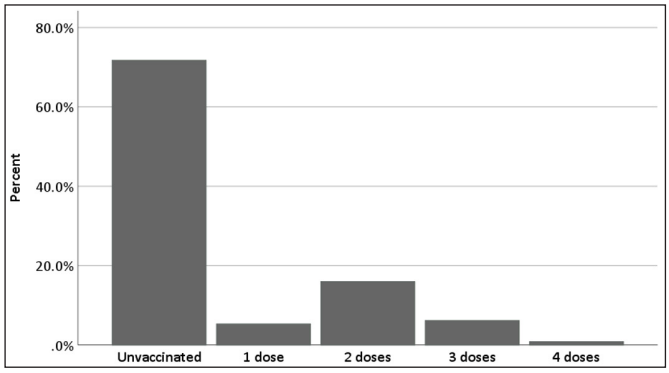

Figure 1. The vaccination status of COVID-19 deaths (%)

The mean time from diagnosis (PCR positive date) to death for COVID-19 deaths was 14.3±11.0 days (median: min-max: 0-80). No statistically significant difference was found between the fully vaccinated and the unvaccinated or incompletely vaccinated individuals in terms of time from diagnosis to death.

The mean time from the last vaccination to death in the vaccinated group was 123.2±90.8 days (median: 86.0; min-max: 8-349). While the median time is 34.0 days for those vaccinated for one dose, it is 140.0 days for those vaccinated with two or more doses (**Figure 2**). This difference was found to be statistically significant ($p < 0.001$).

Diseases reported as the cause of death in the death notification system are presented in **Table 2**. Most COVID-19 deaths (69.2%) were caused by respiratory diseases. ARDS and acute respiratory failure are the leading respiratory problems causing death in COVID-19 patients. They are followed by pneumonia-viral, bacterial, bronchopneumonia, unspecified. Shock and related conditions were observed most frequently among non-respiratory diseases, resulting in death in COVID -19 patients.

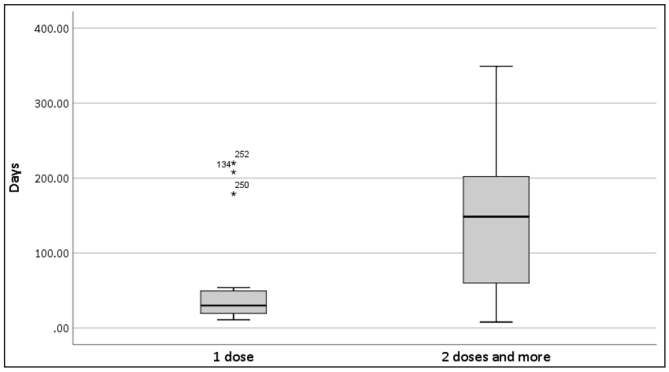

Figure 2. Time from the date of last vaccination to death, according to vaccine doses

Table 2. The reported cause of death in COVID -19 patients in the death notification system

Cause of death	Number	%
Respiratory diseases		
ARDS, Acute Respiratory Failure	187	52.3
Viral & bacterial pneumonia, bronchopneumonia, pneumonia unspecified	57	16.0
Pulmonary embolism	1	0.3
Spontaneous pneumothorax	2	0.6
Total	247	69.2
Non-respiratory diseases		
Septicaemia, Shock, Hypovolemia	75	21.0
Renal diseases	26	7.3
Cardiovascular diseases	6	1.7
Total	110	30.8

Among the causes of death coded with the ICD-10 diagnosis code in the death notification system, 53.8% of the deceased had a comorbid condition (**Table 3**). Hypertension (26.0%) ranked first among comorbid conditions. This was followed by COPD/asthma, cardiovascular disease, and diabetes mellitus with 20.3%, 18.8%, and 14.1%, respectively.

Table 3. Comorbid conditions of COVID-19 deaths

Disease	Number	%
Hypertension (HT) (All types)	50	26.0
Asthma, COPD	39	20.3
Cardiovascular diseases	36	18.8
Diabetes Mellitus (DM)	27	14.1.
Malignant neoplasms	10	5.2
Chronic kidney disease	10	5.2
Others	20	10.4
Total	192	100,0

DISCUSSION

The present study is the first to examine various demographic characteristics, vaccination status, and causes of death from COVID-19 in Turkey at the population level. All COVID-19-related deaths at the district level for two years from 2020, when the COVID-19 pandemic began, to 2022, were examined.

Most of the COVID-19-related deaths included in the current study were male. The mean age of death in this study was 71±13 years. There was no statistically significant difference between men and women regarding age. About 72% of all deaths were over the age of 65. These findings are consistent with the literature (10–14). In a meta-analysis study that included 3,1111,714 global COVID-19 cases, although there was no difference between men and women in terms of risk of contracting COVID-19, male patients were almost three times more likely than women to require an intensive care unit (ITU) (OR=2.84; 95% CI=2.06, 3.92) and a higher probability of death (OR=1.39; 95% CI=1.31, 1.47). The gender bias observed in COVID-19 is a worldwide phenomenon with few exceptions. Identifying how gender affects COVID-19 outcomes will have important implications for clinical management and mitigation strategies.

Vaccination in Turkey started on 14 January 2021 only for high-risk groups and opened to other populations on 25 June 2021. In the current study, as expected, 77% of the studied COVID-19 deaths were unvaccinated or incompletely vaccinated. Several studies showed the effect of vaccination with COVID-19 on reducing hospitalizations and deaths at the community level (15–19). An ecological study aimed to estimate the early impact of the US COVID-19 vaccination program on COVID-19 cases showed the decline in COVID-19 deaths (by 41%, 95% CI –14 to 69 among adults aged 65–74 years and by 30%, –47 to 66 among those aged ≥75 years, compared with adults aged 50 to 64 years) (19). In a retrospective study from Turkey, the length of stay in the intensive care unit and total hospital stay, the need and duration of mechanical ventilation, the percentage of severe and critically ill patients, and mortality were significantly higher in the unvaccinated or incompletely vaccinated group than in the fully vaccinated group (20).

Our findings that most COVID-19 deaths are unvaccinated or under-vaccinated can be considered an indirect indication that COVID-19 vaccines effectively reduce deaths. Additionally, our results show that the time from the last vaccination date to death was approximately 2.5 times higher in those who received two or more doses, and this difference was statistically significant. Studies that prove vaccine efficacy at the population level can help alleviate public ambivalence, not just about COVID-19 but other vaccines.

In this study, 88% of 105 people who died due to COVID-19 despite being vaccinated received all vaccine doses with only inactivated virus vaccine. Scientific evidence shows mRNA vaccines provide better immunity than inactivated virus vaccines (21–23). Our results show that a very small proportion of the COVID-19 deaths were vaccinated with the mRNA vaccine (Comirnaty) supports them. On the contrary, in a hospital-based cohort study from Turkey, no significant difference was found between the inactivated virus vaccine vaccinated group and the mRNA vaccine vaccinated group regarding mortality and admission to intensive care units (24). However, these findings should be supported by further studies comparing the efficacy of different vaccines at the population level.

In the present study, the majority of COVID -19 deaths were due to respiratory diseases such as respiratory failure and pneumonia. Among non-respiratory causes, which account for 30% of deaths associated with COVID -19, shock and related diseases rank first.

Previous studies have shown that common comorbidities are significantly associated with increased risk of adverse outcomes in patients with COVID -19 (25–28). Consistent with the literature, our study found that more than half of the deaths associated with COVID -19 had comorbidities. Hypertension was the most common comorbid condition, followed by COPD/asthma, cardiovascular disease, and diabetes. A meta-analysis showed that hypertension was significantly associated with an increased risk of adverse outcomes in COVID-19 patients based on adjusted effect estimates; this suggests that hypertension is an independent risk factor for predicting severity and mortality in COVID-19 patients (29). Therefore, COVID-19 patients with hypertension deserve further clinical attention.

Strengths and Limitations

Our study has some strengths and limitations. As it is a cross-sectional study, the results are limited to the relevant period. In addition, the reliability of the records limits our study, as we only use records to collect data. Almost a few studies in the literature have retrospectively analyzed COVID-19 deaths. They only studied at the pandemic's beginning and with small sample sizes. One of the strongest aspects of our study is that it is the first study to analyze population-level COVID-19 deaths in Turkey.

CONCLUSION

The results of our study, in line with the literature, showed that deaths from COVID-19 were elderly, males, and individuals with comorbid conditions. In particular, COVID -19 patients with hypertension need more clinical attention. Data from the current study showed that the most common cause of death in COVID -19 patients was respiratory disease. The most striking result from our results is that most COVID-19 deaths were unvaccinated or incompletely vaccinated. Those who were vaccinated were mostly immunized with inactivated vaccines. According to the results, it can be determined that vaccines effectively protect COVID-19 patients from death. However, the preventive effect of inactivated vaccines against death in COVID-19 is limited. Further and comprehensive studies of COVID-19-related deaths at the population level are needed to protect COVID-19 patients from death.

ETHICAL DECLARATIONS

Ethics Committee Approval: The study was carried out with the permission of Istanbul Medipol University Non-Interventional Clinical Researches Ethics Committee (Date: 13.10.2022, Decision No: E-10840098-772.02-6155).

Informed Consent: Not applicable.

Referee Evaluation Process: Externally peer-reviewed.

Conflict of Interest Statement: No conflict of interest was declared by the authors.

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Author Contributions: All of the authors declare that they have all participated in the design, execution, and analysis of the manuscript, and they have approved the final version.

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